

Level of physical activity and quality of life in people after rehabilitation due to COVID-19

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Abstract:

Introduction. The government's public health recommendations to contain the spread of the coronavirus may have affected various areas of everyday life. **Study aim.** The aim of the study was to assess the level of physical activity and quality of life among people after rehabilitation due to COVID-19. **Material and methods.** The research comprised 200 people (110 women aged 50.4±14.8 years and 90 men aged 53.2±13.9 years) from selected medical facilities providing a post-COVID rehabilitation programme under the reimbursement of the National Health Fund (NFZ). Selected somatic indices were measured, on the basis of which BMI (Body Mass Index) and WHR (Waist-to-Hip Ratio) were calculated. The research was carried out using an original, author-designed questionnaire. A shortened version of the IPAQ (International Physical Activity Questionnaire) was applied to assess the level of physical activity before and after the disease, and quality of life was assessed using the WHOQOL-BREF scale (World Health Organization Quality of Life Test-Bref). **Results.** In the opinion of 61.1% of the female respondents and 67.1% of the male respondents, their current level of physical activity differed from the period prior to the disease. Additionally, in the study group, it was shown that the quality of life among people prior to the rehabilitation was lowered, while 1/4 of the respondents considered it unsatisfactory. **Conclusions.** In the group of people infected with COVID-19, a decrease in the level of physical activity undertaken after rehabilitation was observed. Sars-CoV-2 resulted in a post-disease decrease in the quality of life of the subjects.

Keywords: quality of life, physical activity, COVID-19

Introduction

Regardless of age, physical activity is an important aspect of lifestyle and a natural need of the human body. Depending on the period of ontogenesis, it fulfils different purposes. In youth, it strengthens general mobility, in adults, it acts as a prophylactic agent, and in the elderly, it allows for successful aging (Cybulski & Krajewska-Kułak, 2016). Each phase of development is appropriate for undertaking regular physical activity, however, the sooner it occurs, the sooner the preventive and rehabilitation effects will be visible (Gieroba, 2019; Kubińska & Pańczuk, 2018; Rottermund et al., 2015).

Positive changes in the body under the influence of physical effort are widely documented in the literature (Chekroud et al., 2018; Garber et al., 2011; Lipecki & Rutowicz, 2015; Mathieu et al., 2012; Pedersen & Saltin, 2015). Physical activity significantly modifies the metabolism of bone tissue, it corrects posture defects, increases the vital capacity of the lungs and slows down resting heart rate while lowering blood pressure during exercise (Dardzińska, 2016; Wojtyła et al., 2011; Zieliński et al., 2017). Physical exercises enhance the functioning of the immune system, and when undertaken systematically, they help to strengthen and improve health while preventing and supporting the treatment of many diseases (Dymarska et al., 2017).

With age, a noticeable decline in physical activity level becomes visible. This phenomenon is accompanied by a number of involuntional changes (Konieczny & Rasińska, 2016; Łysak et al., 2014). It is frequently forgotten that physical activity is the most important factor positively influencing good general health. Deficits in physical activity are one of the causes of health loss and the occurrence of many lifestyle diseases (Dmowska & Kozak-Szkopek, 2010). Along with industrialisation, physical activity is limited, which is a real threat to physical and mental health (Makai et al., 2016).

The state of the COVID-19 pandemic is a crisis that may negatively affect the somatic and mental health of the population (Pfefferbaum & North, 2020). This disease entity, caused by the SARS-CoV-2 virus, is characterised by a varied course. The infection, in most cases, is asymptomatic or mild, but may develop into a severe state, and consequently, lead to death (Borkowski et al., 2021). Obesity, malnutrition or being

underweight are considered prognostic factors of risk for a severe infection course (Wądołowska et al., 2021). The most common symptoms as a result of infection with the SARS-CoV-2 virus include fever, cough and shortness of breath, malaise, severe weakness, muscle and osteoarticular pain (Borkowski et al., 2021). Other symptoms, occurring at a varying frequency (depending on the variant of the virus), are headaches, loss of smell and taste, accelerated breathing, changes in heart rate, loss of speech or motor skills, nausea, diarrhoea and/or skin changes (Borkowski et al., 2021). In the cardiovascular system, infection can cause myocardial infarction and myocarditis, arrhythmia and heart failure. With regard to the respiratory system, this can lead to its failure, which is a direct life-threatening condition. The SARS-CoV-2 virus has negative impact on almost all systems of the body (Borkowski et al., 2021; Guo et al., 2020; Hoffmann et al., 2020; Ragab et al., 2020; Wądołowska et al., 2021).

In the holistic definition of health, the basic determinant is lifestyle, shaped under the influence of external factors (socio-cultural) and personal resources. Pro-health behaviours related to undertaking regular physical activity and a rational model of nutrition are conducive to maintaining health potential (Grey, 2017). Nutrition is one of the elementary components of a lifestyle that affects human health and its proper functioning. Meeting norms of the physiological demand for nutrients forces planning diversified food rations, taking products from individual levels of the food pyramid into account (Gawęcki & Berger, 2012). Various dietary components are involved in the proper functioning of the immune system. Vitamins D, C, A, zinc, selenium and polyunsaturated fatty acids, responsible for the activation, differentiation and multiplication of immune cells, play a significant role in these processes (Calder, 2020; Mucha & Mucha, 2021; Pludowski et al., 2018; *Q&A on coronaviruses (COVID-19)*, 2020; Uwitonze & Razaque, 2018).

Quality of life is directly related to the sense of health considered in accordance with the definition of the World Health Organization (WHO). It is defined as "an individual way of perceiving one's life position within the cultural context and value system in which one lives, and in relation to tasks, expectations and standards set by environmental conditions. Quality of life HRQOL (Health Related Quality of Life) refers to the perception of disease impact and its treatment on the quality of functioning and life of a person. It is based on three components (physical, psychological and social) ('The World Health Organization Quality of Life Assessment (WHOQOL)', 1995).

Due to the COVID-19 pandemic in March 2020, Poland introduced the first government public health recommendations to hinder the spread of the coronavirus. For this reason, many branches of the economy were closed, including the sports services sector. In addition, restrictions limited the possibility of free movement, also comprising outdoor physical activity. These changes may have contributed to a reduction in the level of physical activity among the population¹.

During the research, there were 19,756.8±6262.3 confirmed cases of COVID-19 in the country and 575,747.4±59162.5 worldwide. The number of deaths in Poland was 454.6±158.1, and worldwide, 9,907.0±1,181.2 (Biernat et al., 2007)².

The significance of comprehensive, individualized sanatorium and recreational rehabilitation among people after infection with Sars-CoV-2 increases the body's re-adaptation to physical activity, manifested, among others, in improving respiratory functions, increasing muscle strength and reducing pain (Kokhan et al., 2022). A rehabilitation stay through optimized intensification of physical activity and the use of therapeutic factors has a positive effect on improving the systemic and immune processes of the body (Aksay, 2021; Mozolev et al., 2020; Wang et al., 2020). This is done with the aim of full or partial recovery after an illness/procedure and the prevention of complications and relapses (Kjærgaard et al., 2020).

Study aim

The aim of the study was to assess the level of physical activity and quality of life among people who underwent rehabilitation due to COVID-19.

Material and methods

The research was carried out from November 2021 to March 2022 among a group of 200 people who had a documented positive test result for Sars-CoV-2 and underwent rehabilitation. The study involved 110 women aged 50.4±14.8 and 90 men aged 53.2±13.9 who were patients of selected medical facilities providing a post-COVID rehabilitation programme under the reimbursement of the National Health Fund (NFZ).

Somatic indices were assessed – body mass (BM) and height (BH), waist (WC) and hip circumferences, BMI (Body Mass Index) and WHR (Waist-to-Hip Ratio). The obtained results were compared to the reference values.

Excess body mass was found in 56.8% of women and 55.4% of men. For all the subjects, BMI was lower in men (25.9 kg/m²) than in women (27.2 kg/m²). These differences were not statistically significant ($p=0.175$). Based on the distribution of BMI values, obesity was found in 29% of women and 19.5% of men. Being overweight was reported in 36.1% of the male respondents and 27.8% of female respondents. Gender did not significantly

¹ <https://covid19.who.int/> [26.12.2021].

² http://apps.who.int/iris/bitstream/handle/10665/42665/WHO_TRS_916.pdf;jsessionid=856018CDFD3F8F4092858D2D7DF46E23?sequence=1 [26.12.2021].

differentiate individual BMI categories ($p=0.408$). Waist circumference for the total group was greater in men than women ($p\leq 0.009$). The distribution of the WHR index indicated android type of obesity among women, while among men, the average value of waist circumference did not exceed the borderline value (94 cm) ($p\leq 0.001$) (Table 1).

Table 1. Anthropometric characteristics of the subjects

INDEX	WOMEN (n=110)	MEN (n=90)
BM [kg]	66.1±18.3*	76.4±17.6*
BMI [kg/m ²]	27.2±6.8	25.9±5.2
WHR	0.84±0.06*	0.91±0.06*
WC (cm)	86.2±15.7**	91.7±14.1**

Significance of statistical differences depending on gender at the level: * $p<0.00$, ** $p<0.01$

The group was dominated by patients from the dolnośląskie (44.2%), śląskie (11.9%) and mazowieckie provinces (17.1%). The average length of the rehabilitation programme for female respondents was 20.2±6.4 days, while for the male respondents, it totalled 19.9±7.2 days. The waiting time for rehabilitation from the date of obtaining a positive result of the RT-PCR test was 5 months in the largest percentage of respondents (37.9%). Kinesiotherapy treatments (71%) dominated among the post-COVID rehabilitation methods. Subsequently, the respondents underwent oxygen therapy (63%), therapeutic massage (53%), physical therapy (44%) and chest tapping (39%). Treatments were performed once (68%) or several times a day (38%). The therapeutic cycle consisted of 10.2±0.6 treatments. The research was carried out via the diagnostic survey method, with the use of an original, author-designed questionnaire consisting of three parts (I - personal data questions, II - eating habits and the use of stimulants, III - the length of the therapeutic cycle and the type of treatments used during rehabilitation). The questionnaire was completed in electronic (Google form, QR code) and paper form.

A shortened version of the International Physical Activity Questionnaire (IPAQ) was applied to assess the level of physical activity before and after the disease (Biernat et al., 2007). The quality of life before and after rehabilitation was assessed using the World Health Organization Quality of Life Test-Bref (WHOQOL-BREF) scale (Wołowicka & Jaracz, 2001). Analysis of the results was conducted using the GNU R 2020 statistical package, with the Wilcoxon and Friedman tests. Basic measures of descriptive statistics were calculated using Microsoft Excel.

Results

The obtained research results indicate that in the period before the disease, the average weekly energy cost of vigorous physical effort of the respondents was significantly higher ($p=0.022$) (Table 2).

Table 2. Comparison of physical activity levels before and after COVID-19

PHYSICAL EXERCISE [MET-min./w.]	BEFORE COVID-19	AFTER COVID-19	<i>p</i>
VIGOROUS	1135.90±1034.75	660.70±1170.67	0.022
MODERATE	342.07±717.50	420.77±911.40	0.536
LOW	466.09±508.77	666.33±594.39	0.132
TIME DEVOTED TO SEDENTARY LIFESTYLE [min./w.]	848.24 ±390.40	869.91±436.70	0.854

Level of significance $p<0.05$

The level of physical fitness presented by the respondents after COVID-19 was also subjectively assessed. Analysis of the obtained data showed that, in the opinion of 61.1% of female and 67.1% of male respondents, their current level of physical activity differed from the period prior to the disease (Figure 1).

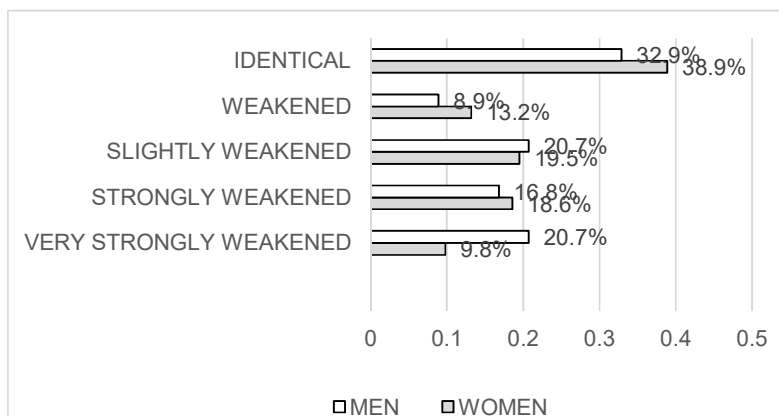


Figure 1. Subjective assessment of physical activity level after COVID-19.

In the study group, the score regarding the perception of one's health status was significantly different. The period prior to rehabilitation was considered by the respondents to be significantly worse. In all four assessed domains of quality of life, the respondents obtained a significantly lower average number of points before rehabilitation (Table 3).

Table 3. Comparison of the results obtained for the WHOQOL-BREF test before and after rehabilitation

EVALUATING QUALITY OF LIFE DOMAINS	BEFORE REHABILITATION	AFTER REHABILITATION	<i>p</i>
OVERALL QUALITY OF LIFE (WHO1)	3.77±0.8	4.0±1.2	0.19
PATIENTS' SELF-ASSESSMENT OF HEALTH STATE (WHO2)	2.88±0.9	3.74±0.9	0.006
PHYSICAL DOMAIN (DOM1)	14.1±2.8	16.4±2.1	0.004
PSYCHOLOGICAL DOMAIN (DOM2)	13.3±2.5	14.9±2.6	0.044
SOCIAL RELATIONS (DOM3)	13.7±3.4	16.3±2.3	0.001
ENVIRONMENT (DOM4)	14.1±1.9	15.7±1.5	0.005

Level of significance $p < 0.05$

Almost half of the respondents (47.1%) continued to experience COVID-like symptoms after rehabilitation, with more of them occurring in men (59.3%) than in women (47.7%). The most common symptoms among men included joint pain (30.6%) and problems with concentration (30.2%). Women more often complained of shortness of breath (25.4%) and a decrease in physical fitness (27.4%) (Figure 2).

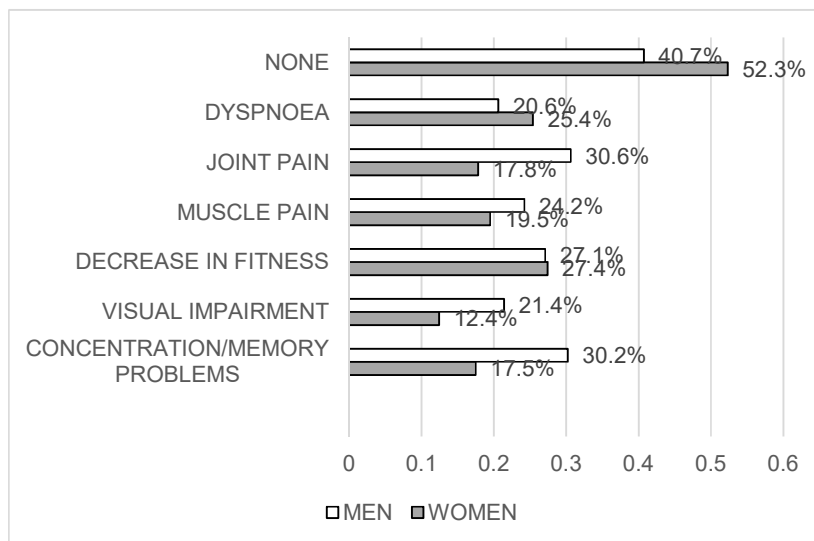


Figure 2. The most common COVID symptoms after treatment.

The vast majority of respondents (85% ♀ and 53% ♂) declared that they would start work after the illness. The respondents who indicated that this issue did not apply to them were of retirement age or students (Figure 3).

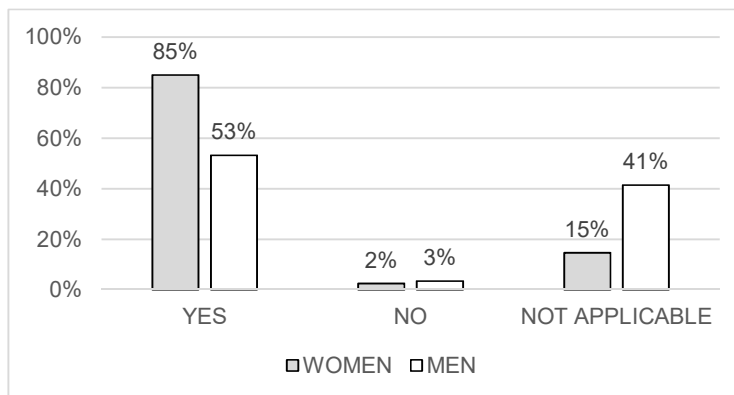


Figure 3. Taking up professional work after COVID-19.

Dietary treatment during post-COVID rehabilitation was more frequent among women than men. Female respondents also participated in activities aimed at promoting health and health education more frequently (Figure 4).

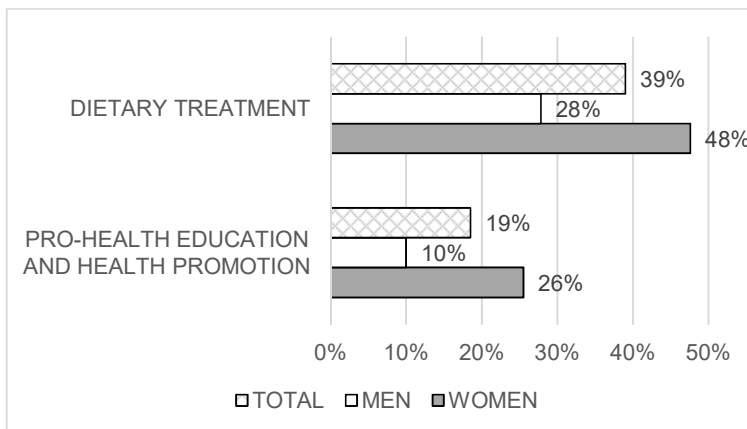


Figure 4. Overweightness and obesity prevention.

From the conducted study, it results that the vast majority of respondents (69%), including 68% of women and 69% of men, declared taking dietary supplements. Among the supplements, vitamin C (24%♀ and 24%♂), vitamin A (17%♀ and 14%♂), fish-oil and omega 3 fatty acids (12%♀ and 14%♂) and vitamin D (15%♀ and 7%♂) were the most popular (Figure 5).

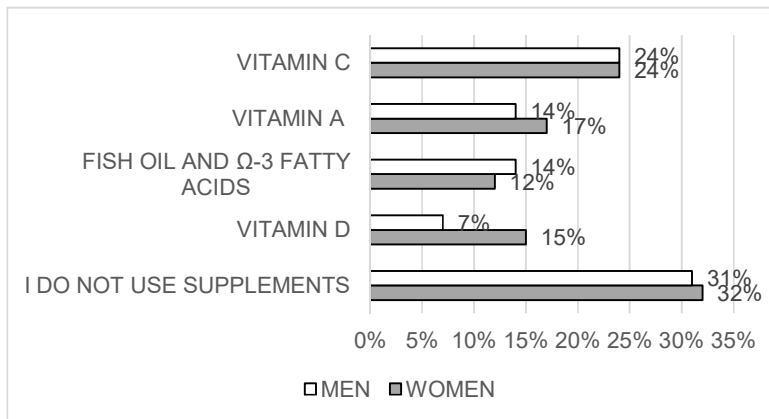


Figure 5. Using supplementation.

The assessment of smoking prevalence showed that the majority of respondents did not smoke tobacco (85%♀ and 61%♂). In the group of smokers, those who smoked less than a pack of cigarettes a day were dominant (10%♀ and 30%♂). The average duration of smoking was 11±8.8 years among women and 18±10.1 years among men (Table 4).

Table 4. Smoking among study participants

FREQUENCY OF SMOKING	WOMEN	MEN
NEVER	85%	61%
A PACK A DAY	2%	3%
LESS THAN A PACK A DAY	10%	30%
MORE THAN A PACK A DAY	3%	6%
DURATION OF SMOKING [years]	11±8.8	18±10.1

The type and amount of alcoholic beverages consumed by the study group varied. Among alcoholic beverages, women most often chose wine (48%), while men chose beer (66%). The frequency of consuming alcoholic drinks was higher in the group of men where, on average, every third respondent consumed alcohol several times a week, and every fourth, every day (Table 5).

Table 5. Alcohol consumption

CATEGORY		WOMEN	MEN
PREFERRED ALCOHOLIC BEVERAGE	HIGH-PROOF ALCOHOL	15%	24%
	WINE	48%	10%
	BEER	37%	66%
CONSUMPTION OF ALCOHOLIC BEVERAGES	EVERY DAY	9%	25%
	SEVERAL A WEEK	43%	35%
	ONCE A WEEK	28%	32%
	LESS THAN ONCE A WEEK	20%	8%

Discussion

Epidemiological data from recent years indicate that overweightness and obesity are a global problem contributing to increased morbidity and mortality. Due to its global nature and adverse health effects, obesity has been classified by the World Health Organization (WHO) as a chronic disease (Jarosz & Barysz, 2006; Szponar, 2003). Research conducted between 2019-2020 by the Food and Nutrition Institute (IŻŻ) / National Institute of Public Health (NIZP) - National Institute of Hygiene (PZH), in cooperation with the European Food Safety Authority (EFSA), has allowed to demonstrate that excessive body mass was observed in 65.7% of male Poles and 45.9% of Polish women, and obesity concerned 15.4% of men and 15.2% of women (Yumuk et al., 2014). It should be emphasized that, in Poland, as well as in other countries, there is a noticeable upward trend in the prevalence of overweightness and obesity. This problem was also noted in our research, where excessive body mass was found in 56.8% of women and 55.4% of men. In the current study, significant sex-dependent differences in waist circumference and WHR were observed, which indicates the occurrence of android obesity (WHR>0.8 in women and 0.9 in men). This is unusual because abdominal obesity is rather male-specific (Alberti et al., 2005; Roszkowski & Chmara-Pawlińska, 2003; Shen et al., 2019).

The treatment of obesity requires comprehensive and multi-directional activity of specialists in various fields, including dieticians, doctors, psychologists and trainers (Kuński, 2003a). In our research, dietary treatment during post-COVID rehabilitation was more frequent among women than men (48% vs. 28%). Women respondents also participated in activities aimed at health promotion and health education more frequently (26%).

Physical activity is an indispensable and elementary component of a healthy lifestyle (Kuński, 2003b; *Poziom aktywności fizycznej Polaków 2018*, 2018). The indicator used to assess the undertaken physical activity is the total average physical exercise performed in one's leisure time, given in MET [min./week] (Metabolic Equivalent of Task). This unit is used to determine the absolute intensity of the effort made and express the cost of physical activity. According to the WHO, the recommended minimum weekly dose of physical activity in leisure time should be 500-1000 MET/min/week (Marchewka et al., 2013). In our research, it was shown that the average weekly energy cost before the onset of COVID-19 reached the highest values in the case of vigorous physical exercise (1,135.90±1,034.75). Attention should be paid to the high values of standard deviations, which could indicate large variation in the mobility potential of the respondents. More than half of the respondents (52.9%) declared undertaking vigorous physical effort, 20.8% of the respondents undertook that moderate, and 26.3% performed low-intensity physical activity. In other studies conducted among people above the age of 50, 21% of the group undertook vigorous physical efforts, 37% moderate, and 42% low, with the average total weekly energy expenditure among men being 1,390.4±1,172.6 MET min/wk and 1,712.3±1,543.6 MET min/wk in women (Krzepota et al., 2013). With age, there is a noticeable decrease in undertaken physical activity, which is confirmed by the results of nationwide studies from 2012 (Rowiński & Dąbrowski, 2012). The insufficient level of physical activity among Poles from before the pandemic was described in the MultiSport Index 2020 study, in which 35.0% of respondents did not undertake regular physical activity (Mucha & Mucha, 2021). From research conducted in 2018 by the Ministry of Sport and Tourism, it was demonstrated that 16.2% of Poles did not comply with the WHO recommendations regarding the recommended level of daily physical activity (Olearczyk & Walewska-Zielecka, 2021). Forced social isolation imposed by restrictions resulting from the COVID-19 pandemic have changed the lifestyle of society (University of Pécs, MTA-PTE Human Reproduction Scientific Research Group, Pécs, Hungary et al., 2019). As a result of introducing a lockdown in spring 2020 and the accompanying consequences (e.g. closure of sports facilities, restaurants, swimming pools and switching to remote work/learning), the amount of free time of Poles had increased (Mucha & Mucha, 2021). The analysis of the MultiSportIndex report from 2020 allowed to note a decrease in the physical activity of Polish persons by 4 percentage points at that time (Mucha & Mucha, 2021).

In our research, the level of physical fitness presented by the respondents after COVID-19 was subjectively assessed, indicating that, in the opinion of 61.1% of the female and 67.1% of the male respondents, their current level of physical activity was different compared to the period prior to the disease. In other studies, it has been shown that 75% of the respondents described their level of physical activity during the COVID-19 pandemic as lower (Mucha & Mucha, 2021). The negative consequences of this sedentary lifestyle on health within the physical and psychological contexts have been widely described in the literature (Haskell et al., 2007; Lovell et al., 2020). Based on the analysis of the results concerning the average time spent sitting, it has been found that after the disease, the respondents led a more sedentary lifestyle, spending more time on this activity than in the pre-COVID period (848.24±390.40 minutes/wk vs. 869.91±436.70 minutes/wk).

The assessment of the quality of life depends on the state of health (Chrobak, 2009; Muszalik et al., 2009). Due to the new and unknown epidemiological situation, there is a limited number of studies on the impact of COVID-19 regarding quality of life in Poland and in the world. In the study group, it was demonstrated that quality of life among people before the rehabilitation was lowered. One fourth of the respondents in the first question (WHO1) considered their quality of life unsatisfactory. In turn, other research allowed to confirm that both men and women rated their quality of life before the pandemic higher than during it (Knudsen & Waerness, 2007). Analysis of the results concerning the impact of the pandemic on subjective satisfaction with life showed that the respondents rated their quality of life higher before the pandemic. Bidzan-Bluma et al., comparing the

assessment of life quality during the pandemic among middle-aged and elderly people indicated that the elderly rated their satisfaction with life and well-being during the pandemic higher than young people (Bidzan-Bluma et al., 2020). In the research conducted by CBOS (Centre for Public Opinion Research), it was observed that age was a differentiating factor in the assessment of the state of social isolation and thus, quality of life resulting from the restrictions imposed by the COVID-19 pandemic. The published analyses show that the greatest decrease in quality of life related to the pandemic was felt by young people. This was in connection with the threat of losing one's job and worsened financial situation. Negative opinions about future financial state were most often expressed by the youngest people, aged 18-24 (43%), less frequently by people aged 25-39, where such fears were expressed by 29% of the respondents (CBOS, 2020).

In this study, the vast majority of respondents (85% of women and 53% of men) declared that they would take up professional work after illness. The individuals who indicated that this issue did not apply to them were of retirement age or student status. Analysing the results of the WHOQOL-BREF test in our research allowed to indicate a significant issue, that is the reduced assessment of one's own health and quality of life after COVID-19 infection and before rehabilitation. In previous studies conducted among populations affected by the pandemic, its significant impact on the mental condition of society has been clearly indicated (Xiao, 2020). The results of our study obtained in individual domains prove a decrease in quality of life among all the examined areas and indicate a statistically significant lowered assessment of quality of life in the psychological domain. This may be due to the introduced restrictions, social distancing as well as a feeling of helplessness among people in the face of the disease. To a large extent, limited interpersonal contacts necessary to maintain a person's mental balance could have had negative impact on the mental state of the subjects (Kmietowicz, 2020). The disease has significant effects on patients' quality of life due to its chronic nature, frequency of exacerbations and varied symptoms. Chronic diseases of the respiratory system, due to the limitation of airflow through the respiratory tract (Bak-Drabik & Ziora, 2004), could probably be considered the same as COVID-19 due to the occurrence of similar dysfunctions to this system. Analysis of the results of research obtained by Kupcewicz and Abramowicz on sense of life satisfaction among patients with chronic obstructive pulmonary disease was varied. As much as 54% of the respondents had a low assessment of life satisfaction, while the remaining 46% indicated an average level. In the study group, there were no people who considered that their level of satisfaction with life as high (Kupcewicz & Abramowicz, 2015). In our research, there was also no respondent who considered their quality of life to be high. When analysing the level of satisfaction with life, it was noted that the duration of the disease had significant influence on the result. It was proved that the longer the duration of the disease, satisfaction with life of the respondents was statistically significantly lower (Kieczka, 2010). It can be seen that time is a differentiating factor, which is why it is so important to shorten the patient's treatment period as greatly as possible. The waiting time for rehabilitation from the date of obtaining a positive result of the RT-PCR test in the highest percentage of respondents in our research (37.9%) was 5 months.

The world of medicine in the era of a pandemic faced the challenge of diagnosing and treating disease syndromes initiated by COVID-19. In view of the growing number of people recovering from this illness, the need for rehabilitation and medical care for convalescents is growing. Post-COVID rehabilitation includes the reduction of disease symptoms and complications (Borkowski et al., 2021). In our research, almost half the group (47.1%) still experienced COVID symptoms following rehabilitation. The most common symptoms among the surveyed men included joint pain (30.6%) and problems with concentration/memory (30.2%). Women more often complained of shortness of breath (25.4%) and decreased physical fitness (27.4%). In other studies conducted among patients hospitalised for COVID-19, its most common symptoms included shortness of breath (66.3%), anxiety (42.6%), drowsiness (35.6%) and pain (22.8%)(Davis et al., 2021). The cause of coughing in the course of COVID-19 is the synthesis of the SARS-CoV-2 virus with the angiotensin-converting enzyme type II (ACE-2), which is present on the mucous membranes of respiratory system cells. The virus binds to alveolar pneumocytes entering the cell and binding to respiratory epithelial cells (Borkowski et al., 2021). Long-lasting COVID symptoms may indicate the occurrence of 'Long-COVID' (Borkowski et al., 2021). This ailment is associated with SARS-CoV-2 infection lasting more than 4 weeks from the onset of the first symptoms (Borkowski et al., 2021). The scale of the problem is evidenced by research that has been conducted among 3,762 people from 56 countries, where the most frequently reported symptoms post rehabilitation included fatigue (78%), long-term fatigue (72%) and cognitive disorders (55%) (Van Herck et al., 2021). In other studies, 20 to 30% of respondents complained of shortness of breath 2-3 months after the onset of the first COVID-19 symptoms (Davis et al., 2021; Sudre et al., 2020; Van Herck et al., 2021). In the present study, it was found that men, as a result of rehabilitation, less often felt discomfort associated with shortness of breath than women. These results corresponded with the analysis based on which it was established that an estimated 21% of patients complained of shortness of breath within 5 weeks of SARS-CoV-2 infection, while cough was the second most frequently reported symptom (11.4%) (*Office for National Statistics COVID-19 Infection Survey. Coronavirus (COVID-19), 2021*).

From among the study participants, 85% of women and 53% of men declared taking up professional work after the disease. In other studies, due to illness, 45% of respondents were forced to reduce employment, and 22% were unable to resume work (Davis et al., 2021).

A properly balanced diet, which is a source of essential micro- and macro-elements, can increase the immune resistance so needed in the era of a pandemic (Aman & Masood, 2020). The study allowed to indicate that the vast majority of respondents (69%), including 68% of women and 69% of men, declared taking dietary supplements. Among the supplements, vitamin C, vitamin A, fish-oil and omega 3 fatty acids and vitamin D were chosen most often. Research allows to assume that a diet containing the above-mentioned ingredients may contribute to alleviation of inflammation occurring as a result of cytokinin activity during infection caused by SARS-CoV-2 (Iddir et al., 2020). In a retrospective analysis of over 700 cases of SARS-CoV-2 infection among men living in Indonesia, it was suggested that low levels of vitamin D (20-30 ng/ml) increase the risk of mortality due to COVID-19 up to 13 times (Raharusun et al., 2020). A similar trend was observed in Switzerland, where patients infected with the virus had significantly lower levels of vitamin D compared to those who were not detected with the SARS-CoV-2 virus (11.1 ng/ml vs. 24.6 ng/ml) (D'Avolio et al., 2020). Calcitriol, by stimulating the production of cathelicidin and defensin, which inhibit the rate of viral replication, may reduce the risk of viral infection and support the treatment process (Brugliera et al., 2020). In our research, vitamin D was supplemented more often by women than men (15%♀ and 7%♂). It is worth noting that this was the least frequently taken vitamin with confirmed anti-inflammatory properties.

With regard to supplementation, the subjects most often took vitamin C. Its proven anti-inflammatory effect is used to fight infections, which is confirmed by examples from literature in the subject (Iddir et al., 2020). In research, it has been suggested that its supplementation can be used to prevent viral infections as well as help treat them. One of the compounds with a key effect is rutin, which blocks an enzyme important for the life cycle of the coronavirus - COVID-19 protease (COVID-19 3CLpro) (Xu et al., 2020). Due to the low costs and the potential positive effects of vitamin C supplementation, its use by the respondents to improve immunity seems to be a justified and purposeful action.

In research, the significant anti-inflammatory properties of Ω -3 fatty acids have been noted within the context of diet among people diagnosed with SARS-CoV-2 infection. By acting on the cell membrane, they limit the spread of infection and lead to inactivation of enveloped viruses, including the aforementioned SARS-CoV-2 (Das, 2020). It has been shown that the anti-inflammatory properties of Ω -3 acids, by limiting the excessive production of pro-inflammatory cytokines in alveolar cells of the lungs, reduce the risk of SIRS (systemic respiratory failure syndrome) in patients diagnosed with SARS-CoV-2 (Panigrahy et al., 2020). In our research, supplementation with Ω -3 fatty acids was declared by 12% of women and 14% of men. Due to the fact that the human body is not able to synthesize Ω -3 acids and they must be supplied with food rations (Jurek, 2020), the supplementation used by the respondents was a desirable phenomenon. It must not be forgotten that no supplementation will be able to replace a properly balanced diet. Therefore, these ingredients should be supplemented with caution, as scientific research in this area is still limited (Liu et al., 2020).

In numerous studies, a significant relationship has been indicated between long-term alcohol abuse and the generation of reactive oxygen species and an increased risk of many serious diseases. It has been shown that ethyl alcohol has an inhibitory effect on the cells of the immune system, impairing elements of the primary innate immune response (Jankowski et al., 2013). In our research, the frequency of consuming alcoholic beverages was higher in the group of men, where, on average, every third respondent consumed alcohol several times a week, while every fourth respondent every day. It should be noted that increased consumption of ethyl alcohol is associated with the risk of systemic and local metabolic disorders within most systems of the human body, including the immune system (Jankowski et al., 2013).

The relationship between smoking and SARS-CoV-2 infection is ambiguous. It is assumed that the use of this stimulant increases the activity of the ACE2 receptor, which may contribute to increased susceptibility to infection (Brake et al., 2020). In their study, Liu et al. showed that smoking contributes to the progression of COVID-19 disease (Liu et al., 2020). In a different study by Guan et al., it was confirmed that smokers are almost 2.5 times more likely to require admission to the intensive care unit (Guan et al., 2020). Assessing the frequency of tobacco smoking in our research showed that the majority of respondents did not smoke tobacco (85%♀ and 61%♂). Which, in the light of the above-mentioned reports, seems to be a positive phenomenon. However, in the research by Calmes et al., smoking was not a risk factor for being admitted to the intensive care unit or death (Calmes et al., 2021). The authors of the above-mentioned study suggest that active smoking may even serve a protective role against COVID-19 by damaging cells that are a kind of gateway for the SARS-CoV-2 virus, e.g. type 2 pneumocytes.

Conclusions

In conclusion, assessing the level of physical activity and quality of life among people who have undergone rehabilitation due to COVID-19 has provided results that can help understand the impact of the pandemic on the health and well-being of patients. In the study group, a decrease in the level of undertaken physical activity was observed after infection. As a result of the disease, there was also a reduction in the quality of life through negative impact on all spheres of human life (physical, psychological and social). In addition, a relatively high level of so-called everyday health practices manifested, among others, in avoidance of stimulants (alcohol, tobacco), which may be confirmation of the positive trend regarding changes in the lifestyle of the respondents. A useful tool for assessing quality of life among people undergoing rehabilitation after COVID-19

may be the WHOQOL-BREF questionnaire. In addition, a program should be developed and implemented to re-encourage the public to engage in regular physical activity. Due to the still small number of reports on the level of physical activity and quality of life in people after COVID-19 caused by the SARS-CoV-2 virus, it seems reasonable to conduct further research in order to counteract the negative effects of this disease.

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